

CLAIMS

1. A nonvolatile semiconductor memory comprising a memory array which includes a plurality of nonvolatile memory elements which store data in terms of threshold voltage levels, said memory being adapted to implement:

a first operation of applying a first voltage which corresponds to an unselection state at data reading, to plural word lines in said memory array and detecting a current flow through any of the memory elements on the word lines, thereby finding the presence of a failing element in said memory array; and

a second operation, which is implemented upon finding the presence of a failing memory element by said first operation, of applying said first voltage to one of said plural word lines, while applying a second voltage, which is lower than said first voltage, to remaining word lines and detecting a current flow through any nonvolatile memory element, thereby pinpointing a failing memory element having a threshold voltage lower than a prescribed voltage level.

2. A nonvolatile semiconductor memory according to claim 1, wherein said first and second operations are initiated in response to entry of control signals and address signals from the outside, and a result of detection of said second operation is released to the outside.

3. A nonvolatile semiconductor memory comprising a memory array which includes a plurality of nonvolatile

memory elements which store data in terms of threshold voltage levels, said memory being adapted to implement:

a first operation of applying a first voltage which corresponds to an unselection state at data reading, to plural word lines in said memory array and detecting a current flow through any of the memory elements on the word lines, thereby finding the presence of a failing element in said memory array;

a second operation, which is implemented upon finding the presence of a failing memory element by said first operation, of applying said first voltage to one of said plural word lines, while applying a second voltage, which is lower than said first voltage, to remaining word lines and detecting a current flow through a nonvolatile memory element coupled to any of said word lines, thereby pinpointing a failing memory element having a threshold voltage lower than a prescribed voltage level; and

a third operation of raising the threshold voltage of said failing memory element having the lower threshold voltage on said one word line by use of data which is held in a read-out amplifier by said second operation.

4. A nonvolatile semiconductor memory according to claim 3, wherein said memory array comprises a plurality of first memory element sets each including a plurality of nonvolatile memory elements coupled in parallel to a first bit line or a first source line.

5. A nonvolatile semiconductor memory according to

claim 4, wherein said memory array comprises a plurality of second memory element sets each including a plurality of said first memory element sets, said first operation being implemented for each of said second memory element sets at a time.

6. A nonvolatile semiconductor memory according to claim 5 including a plurality of said memory arrays, said first and second operations being implemented concurrently for said plural memory arrays.

7. A nonvolatile semiconductor memory according to claim 6, wherein said first operation is or said first, second and third operations are implemented at the time of power-on.

8. A nonvolatile semiconductor memory according to claim 6, wherein said nonvolatile memory elements have their threshold voltage shifted up by a writing operation and shifted down by an erasing operation, and

wherein said first operation or said first, second and third operations are implemented at the time of power-on following a power supply cutoff during the erasing operation.

9. A storage device comprising:

a nonvolatile semiconductor memory including a memory array which includes a plurality of nonvolatile memory elements which store data in terms of threshold voltage levels, said memory being adapted to implement:
a first operation of applying a first voltage which

corresponds to an unselection state at data reading, to plural word lines in said memory array and detecting a current flow through any of the memory elements on the word lines, thereby finding the presence of a failing element in said memory array; and

a second operation of applying said first voltage to one of said word lines, while applying a second voltage, which is lower than said first voltage, to remaining word lines and detecting a current flow through any nonvolatile memory element, thereby pinpointing a failing memory element having a threshold voltage lower than a prescribed voltage level,

and adapted to release results of finding and detection of said first and second operations to the outside; and

a control circuit which is adapted to issue control signals and address signals for initiating said first and second operations to said nonvolatile semiconductor memory,

said control circuit issuing a first control signal and a first address signal for initiating said first operation to said nonvolatile semiconductor memory, issuing to said nonvolatile semiconductor memory, depending on the result of finding of said first operation, a second control signal and a second address signal for initiating said second operation, and issuing to said nonvolatile semiconductor memory, depending on the result

of detection of said second operation, a third control signal and a third address signal for initiating a third operation which raises the threshold voltage of the nonvolatile memory element having the lower threshold voltage than the prescribed voltage level detected by said second operation.

10. A storage device according to claim 9, wherein said memory array comprises a plurality of first memory element sets each including a plurality of nonvolatile memory elements coupled in parallel to a bit line or a source line.

11. A method of detecting and recovering a failing memory element for a nonvolatile semiconductor memory including a memory array which includes a plurality of nonvolatile memory elements which store data in terms of threshold voltage levels, said method comprising:

in a first operation, applying a first voltage which corresponds to an unselection state at data reading, to plural word lines in said memory array and detecting current flows through memory elements on the word lines, thereby finding the presence of a failing element in said memory array;

in a second operation, which is implemented upon finding the presence of a failing memory element by said first operation, applying said first voltage to one of said plural word lines, while applying a second voltage, which is lower than said first voltage, to remaining word

lines and detecting a current flow through any nonvolatile memory element, thereby pinpointing a failing memory element having a threshold voltage lower than a prescribed voltage level; and

in a third operation, raising the threshold voltage of the nonvolatile memory element having the lower threshold voltage than the prescribed voltage level on said one word line by use of data which is held in a read-out amplifier by said second operation.